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SATELLITE TO STUDY "SPACE WEATHER"

The National Aeronautics and Space Administration soon will launch another Explorer satellite to unravel some of the scientific mysteries of how "space weather" affects man's daily life and his future exploration of space.

The 89-pound satellite, S-3a, similar to the highly successful Explorer XII placed into orbit last year, will be launched from Cape Canaveral, Fla., no earlier than October 2, using a Thor-Delta rocket. If successful, this will be the 12th straight launch for the Delta continuing its unprecedented record for U. S. rocketry.

The Delta vehicle will launch the spacecraft at an inclination angle of 33 degrees from the equator. Due to the highly eccentric orbit, the small power of its transmitter, and the anticipated orbital period of 31 hours, several days will pass before an accurate orbit can be confirmed. This orbital period will make the spacecraft visible for approximately 23 hours a day at stations on the apogee side of the earth.

The unusual, and difficult-to-achieve orbit will take the satellite out as far as 53,000 miles and bring it back to within 185 miles of the earth each 31 hours.

Traveling this path, the satellite's sensitive electronic instruments will seek to learn more about electrons and protons, the minute building blocks of all matter in space.

If, for example, one were to gather all the electrons in the artificial radiation belt created by the nuclear

explosion last July 9, their mass would be less than one-tenth of an ounce. However, energetic particles play leading roles in the phenomena of "space weather" which must be better understood if man and his instruments are to journey safely into space.

These particles, many of which possess very high energies, travel at nearly the speed of light. They are responsible for some of the spectacular and intriguing space phenomena that we observe on earth: Disturbances in the reflective sky layer known as the ionosphere which disrupts communications throughout the world; creation of the startling beautiful display of aurorae, observed last year as far south as Washington, D. C. Possibly they have a role in modifying the earth's weather.

Infinitesimal as they are, they can harm man and damage his instruments in the exploration of space. An understanding of their life histories, just as we seek to learn the scientific causes of hurricanes and tornadoes, -- how they are created, how they live and how they die -- can advance other national objectives of manned flight, and the use of space for such foreseeable practical benefits as communications, weather forecasting and navigation.

Principal target of the S-3a is to determine the particle population and their energies in the magnetosphere and the regions of interplanetary space beyond. We know the sun is the principal villain, or hero, as the case may be. The phenomena themselves comprise one of the biggest mysteries in the history of mankind.

The magnetosphere begins several hundred miles up and stretches thousands of miles into space. This in itself is a mystery. In this region are the natural Van Allen radiation belts discovered by the Explorer I satellite in 1958.

We have swiftly gained knowledge of this region through the satellites which followed the pioneering work of Explorer I. But like all great discoveries, each new satellite opened more unanswered scientific questions.

Explorer I told us that there were energetic particles trapped above the earth and that the earth's magnetic field probably acts as a storage bin for these bits of matter that spiral around the earth's magnetic force lines, a cross section which would look much like the shape of a lima bean. But it remained for other satellites to answer the intriguing

riddles of how many particular particles of a certain energy range were in a particular area of space. Today, after several years of space exploration we are still unable to come up with an accurate model of this phenomena because of insufficient data. It undoubtedly will take several more satellites, and many more years before we come anywhere near to an understanding of the processes involved.

As an example: It was thought from early satellite experiments that the Van Allen radiation consisted of two distinct belts -- one primarily of electrons and the other of protons. As with many scientific theories, this was shattered by hard investigative facts. Explorer XII determined that there was no such distinction; rather that the magnetosphere is one big trapping region with particles having different characteristics in various areas of space.

Instruments on spacecraft that preceded Explorer XII could possibly have detected this discrepancy had they been finely tuned for such a definite investigation area. But changing solar activity may be the culprit. Perhaps the particle population and energies change with the variation of the sun's own "weather," again an unknown.

Almost the same holds true for magnetic field measurements by satellites, which are enabling us to learn more about the earth's interior by leaving this planet than by remaining on it. Vanguard III gave one of the first measurements of the earth's magnetic field from space. However, it required Pioneer V and Explorer X to detect the area in space where the earth's magnetic field leveled off and the interplanetary magnetic field assumed command. However, Explorer XII, more accurately pinpointed the precise area and also provided the dividend that there may be a turbulent transition region between the earth and interplanetary fields.

Another piece in the space phenomena puzzle is concerned with a theory that has intrigued scientists since 1830. Then it was postulated that there was a ring current, separate from the earth's magnetic field attraction, circling the earth at some unknown position in space. At first, data from Explorer VI indicated that it had detected this current. However, further analysis made this dubious. But, this thread of evidence whetted scientific appetites. Succeeding satellites, Pioneer V, Explorer X, Explorer XII investigated this area, but with little success, according to data analyzed to date. S-3a may shed more light on this space mystery.

These unknowns may be partially solved but no one expects a complete answer, except through future spacecraft designed specifically to monitor the sun, the ionosphere, and how energetic particles -- particularly the dangerous solar protons -- traverse the 93 million miles from the sun to earth.

One such satellite to be launched next year, will spend most of its time in interplanetary space between earth and the moon, waiting to record these proton events. Assessing the possible damage of these particles is mandatory for support of the Apollo manned lunar program.

Still another series of satellites, OSO's (Orbiting Solar Observatories), will continue to monitor the sun to learn the processes involved in sending out these dangerous radiations. From this program alone could come a system for predicting when the sun is likely to emit radiations dangerous to man. As weather forecasts today indicate safe flying weather, so could such a system indicate safe space "flying weather."

Instruments on S-3a will not be able to precisely measure the artificial radiation belt because they were designed and built prior to its creation. However, S-3a should give world scientists a more complete picture of the changes, induced by less solar activity, or by effects of the nuclear explosion, in the natural radiation zones.

A sister satellite, S-3b, using the spare flight unit of the S-3a, but with different instrumentation to measure the particular artificial radiation belt particles, is scheduled to be launched in an expedited program before the end of the year. This independent attack will seek to determine how the belt is decaying with time, assess the effects of the belt on future satellites, and give the scientific community additional basic information on the artificially-created environment.

Most important, S-3a will carry a solar cell experiment to determine the effect of both the natural and artificial radiation on satellite power sources. These cells convert about 15 percent of the sun's energy into usable electricity.

It is known that man and instruments can safely traverse both the artificial and natural radiation regions if there is adequate shielding. However, because of these radiations, the lifetime of S-3a may vary from a month to a year. The spacecraft's highly elliptical orbit will keep it farther

out in space most of the time, away from the degrading effects of the radiation. S-3b, which is specifically designed to remain in the artificial radiation zone, will have its solar cells coated with 60 mil thick glass. In contrast, S-3a, like Explorer XII, moving quickly through the zones, will have a 6 mil thick coating.

Although the mystery of space characteristics will take years, and many more satellites to unravel before scientists have an accurate model of the phenomena, a general picture has emerged:

It is now believed that when an eruption occurs on the sun, a huge tongue of magnetic field lines, with their roots remaining on the sun, is sent out into space -- perhaps towards earth, but usually in many directions.

According to one hypothesis -- and the S-3a spacecraft should provide more understanding -- these lines, in effect, form a magnetic "bottle." Cosmic rays from outer space -- also possessing very high energies -- are excluded, with the "wind" or plasma, erupting from the sun being confined to within the "bottle."

This plasma, properly the fourth state of matter -- neither solid, liquid nor gas -- is composed of low energy charged particles. It, through supposedly known rules of physics, in turn, creates another magnetic field that moves along with it. It is believed that higher energy particles spiral around the bottle, just as magnetosphere particles spiral around the earth, and they are carried along by the magnetic field lines.

But it remains unclear, and is subject to scientific debate, whether these particles start out with high energies or whether they acquire most of this energy by being accelerated to high velocities when they are pushed along by the magnetic field. One thing is known: When these particles reached such spacecraft as Explorer XII, Explorer X and Pioneer V, there was a spectrum of energy from the speed of light on down.

It is believed that this solar tongue continues to expand, as an onrushing tide, and eventually envelops the earth's magnetosphere, distorting it. Some scientists think that the magnetosphere is compressed toward the earth on the sunlit side, but assumes an ice cream cone-like shape on the opposite side of the earth, which extends out to many thousands of miles.

The S-3a, taking over where Explorer XII left off, will gather data leading to a better understanding of this phenomena. In addition, geoprobes will have to be sent out even greater distances in space to provide more conclusive evidence of the extent of these boundaries, if in effect, they can be proved.

Much of the success of S-3a depends on the tricky task of correctly aligning the spacecraft in respect to the sun when it is placed into orbit. This critical position in space perhaps can be visualized by thinking of the earth revolving around the sun each 365 days.

Next, imagine the earth with its magnetosphere enveloping it in a shape like an ice cream cone -- the ice cream top compressed close to the earth's surface on the sunlit side, and tapering off cone-like on the side away from the sun. Then visualize the highly elliptical orbit of the spacecraft, inclined about 75 degrees from the sun when it is first injected into orbit. The angle toward the sun will become higher each month. As the angle to the sun increases, the satellite -- orbiting the earth as the earth orbits the sun -- probes various areas of the magnetosphere. In six months, the satellite at times will be completely enveloped by it, but at other times will be in interplanetary space beyond, constantly plotting boundaries and the population of the particles.

The Goddard Space Flight Center, Greenbelt, Maryland, has been assigned project management responsibility for the S-3a under the overall direction of the Director, Office of Space Sciences, Geophysics and Astronomy Programs, NASA Headquarters. Dr. John Naugle is Program Chief. Eugene Ehrlich, NASA Headquarters, is Project Officer. Paul Marcotte is Project Manager. Dr. Frank B. McDonald is Project Scientist. Essentially the project consists of six experiments:

- . A cosmic ray experiment, by Dr. Frank McDonald, an ion-electron detector experiment, by Leo Davis, and a solar cell experiment, by Gerry Longanecker, all by Goddard Space Flight Center.

- . A proton analyzer experiment by (Dr. Michael Bader) the Ames Research Center of NASA.

- . A trapped particle radiation experiment by (Dr. Brian O'Brian) the State University of Iowa.

A magnetometer experiment by (Dr. Laurence Cahill) the University of New Hampshire.

In addition, there is a Goddard photocell optical sensing system by James S. Albus that will furnish information on the **satellite's** orientation in space.

THE DELTA LAUNCH VEHICLE

The launch vehicle for the S-3a is the NASA-developed Delta, a three stage rocket which has performed flawlessly in the last eleven of its 12 launch attempts. Delta is nine stories high and weighs 57 tons.

The vehicle's first stage is a 60-foot modification of the Air Force-developed Thor (SM-75) and generates 170,000 pounds of thrust during the two and one-half minutes its 50 tons of propellant burn.

The DM-19 Thor booster used on previous Delta launch vehicles has been replaced with a model DM-21 for this and future Delta vehicles. The DM-21 differs primarily in that the thrust is increased from 150,000 pounds to 170,000 pounds by substitution of the Rocketdyne Block II engine.

The **second stage is** 17 feet tall and weighs a little more than two and one-half tons. It is powered by an **Aerojet-General** liquid engine which develops 7,500 pounds of thrust and burns slightly less than two minutes.

Delta's one-half ton, solid propellant third stage is five feet high and uses an Allegany Ballistics Laboratory ABL 248 engine with a thrust of 3000 pounds. Its burning time is 40 seconds.

For a minute and a half after lift-off, Delta is guided by its Thor auto-pilot. After burn-out of the Thor booster, a Bell Telephone Laboratories radio guidance system makes refined velocity and steering corrections as needed. Shortly after first stage burn-out separation, and after ignition of the second stage, **the fairing--covering the third stage and the S-3a payload--is jettisoned.**

Second stage burning ends about four and one-half minutes after lift-off. The vehicle, with second and third stages still attached is now at an altitude of about 125 miles. At this point a six-minute coasting period occurs. During this period, guidance is provided by a 42-pound flight control system contained in the second stage. The satellite and the third stage are spin stabilized by small rockets mounted on a "spin table" between the second and third stages. At the end

of the coast period--about ten minutes after launch--the second stage separates and third stage ignition occurs. Soon the required orbital velocity of about 19,000 miles per hour is reached and the satellite, trailed by the third stage, is injected into orbit.

Program Manager for the Delta is T. B. Norris, of NASA Headquarters. The Goddard Delta vehicle manager is William R. Schindler. Robert H. Gray heads the Goddard Field Projects Branch at Cape Canaveral.

TECHNICAL DESCRIPTION

S-3a, utilizing a highly eccentric orbit will extend the systematic monitoring of solar activity, cosmic ray phenomena, and the correlation of energetic particles activity with observations of the earth's magnetic field. It will also monitor transient magnetic fields associated with plasma streams.

Following studies made by Exploer XII, the satellite's refined instrumentation and sensors with improved accuracy and range, should provide continuity to previous studies of the effects of solar flares, particle accelerations, and cosmic ray modulation in changing magnetic fields and related phenomena, particularly in the important time period close to the solar minimum.

The highly eccentric orbit will permit the satellite to sweep over several scientifically interesting and highly important regions. As the satellite sweeps out to "near space" regions it will traverse the radiation belt of trapped charged particles, identifying and quantitatively measuring them along with their associated magnetic fields. Beyond this region, some idea of the nature of the solar winds, solar particles, the extent and direction of the earth's magnetic field, the transient magnetic fields of plasmas, and primary cosmic radiation, is expected to be gained.

In addition, S-3a will monitor and systematically study these regions. This is necessary for development of valid theories which can explain the nature and origin of the physical processes and phenomena involved.

Primary objective of the satellite is to describe completely the trapped corpuscular radiation, solar particles, cosmic radiation, and the solar winds, and to correlate the particle phenomena with magnetic field observations. These objectives are:

1. To map the particle intensity including lower energy particles, of the magnetosphere in greater detail.
2. To study the time variations of the intensity of trapped radiation in the magnetosphere and their relationship to solar activity.
3. To determine the lifetime of particles in the magnetosphere.
4. To look for evidence of local acceleration of charged particles.
5. To determine the frequency of occurrence of solar-particle bombardments, especially those of low intensity or low-energy which may not be recorded on ground monitors.
6. To study the possible injection of solar particles into the magnetosphere.
7. To obtain data useful for studying the modulation mechanism of cosmic radiation.

The experiments will measure particle spectra from energies of a few ev to 10^9 ev, and magnetic field measurements down to a lower limit of several gamma.

Spacecraft and subsystems (See attached diagram)

An octagon-walled platform, fabricated from nylon honeycomb and fiberglass, houses most of the instruments and electronics. They are mounted on the periphery of the platform to obtain the highest possible roll moment of inertia and to assure spin stability about the roll axis.

The transmitter is located in the base of the spacecraft. Thus, heat generated by the transmitter is dissipated through the structure and aluminum cover of the spacecraft.

A magnetometer package, containing three orthogonally mounted saturable-core magnetometers and calibration coils, is located on a boom, forward of the platform to reduce field effects from the electronics and instruments.

Four spring-loaded solar cell paddles extend from the main structure. The paddles are oriented to allow a uniform solar cell projection area at any spacecraft solar attitude. The paddles are folded along the last-stage rocket to permit their installation within the nose fairing. They are erected during flight. A despin device reduces the roll rate to approximately 31 rpm after last-stage burnout. Erection of the paddles further reduces the roll rate to approximately 12 rpm. Basic spacecraft dimensions are shown in the attached diagram.

Telemetry Systems. The telemetry system on S-3a operates continuously so that all data transmission is in real time. The system is of the pulse-frequency-modulation (PFM) time-division multiplex type, meaning that the modulation is composed of bursts of frequency separated in time by periods of no oscillation. Equal time intervals are devoted to the duration of a burst and to a period of no oscillation except for a synchronization reference composed of a 50-percent shorter period of no oscillation followed by a 150-percent longer burst. This reference defines the origin of each frame. A frame is defined as 16 sequential bursts, each burst representing a channel.

The telemetry transmitter is operated at a frequency of 136.440 Mc with a nominal output power of two watts. The telemetry antenna for the S-3a is a modified crossed dipole turnstile. The elements are fed from an RF coaxial harness that incorporates a hybrid ring to divide the power and line lengths to phase the elements.

Optical Aspect Sensor. The spacecraft carries an optical aspect system to determine the orientation in space of the satellite as a function of time.

The orientation is determined by using solar sensors only. Six photo-diodes give 100 degrees digital indication of the sun's elevation with respect to the spin axis of the satellite -- the 180 degrees from pole-to-pole being divided into 63 parts. The time within the telemetry frame of the sun's appearance is also coded in binary form. Read-out of all the time and position information is on two telemetry channels.

EXPERIMENTS

Proton Analyzer Experiment, Ames Research Center. Purpose of this experiment is to measure low-energy proton flux and spectrum in space beyond six earth radii. The data obtained

will increase our knowledge of proton concentrations in solar winds caused by solar flares. These data will also be useful for correlating particle activity in space and in the magnetosphere with solar activity.

The proton concentrations, as a function of kinetic energy, are determined by admitting the protons through a slit of known dimensions in the satellite skin. A variable curvedplate electrostatic analyzer separates the particles according to their energy. This results in a particle current which is a function of the energy level and is measured by an electrometer circuit. By proper calibration of the analyzer in the laboratory, and given the geometrical and electrical characteristics, the particle concentration outside the satellite can be determined.

At present there is considerable uncertainty regarding satellite potential, especially in the radiation belt. Therefore, it is planned to maintain resolution down to 200 ev and provide an order of magnitude answer on concentrations at energies below this level. This effectively dictates a 20 Kev upper limit which is also the highest energy level expected from solar wind protons. A dynamic range of 10^4 is planned for the proton current measurement, which is sufficient to cover the extremes in expected solar proton fluxes. The basic accuracy of the current measurement is ± 3 percent. The energy measurement accuracy over the 0.2 to 20 kev range is intended to be ± 5 percent. These accuracies are based on the assumption of 100-cps transmission bandwidth and a 1-rps spin rate.

There will be no mass-analysis performed, but this experiment will be highly accurate for protons as these are believed to constitute at least 85 percent of the positive ion population. Since the flux at a given energy is inversely proportional to the square root of the mass, the error in using this figure for making a heavier particle correction should be quite small.

The analyzer package is a rectangular box 3 x 4 x 2 inches weighing 391 grams. Power consumption is 145 milliwatts and will be supplied from ± 12 volts dc source with a regulation of ± 1 percent.

Magnetic Field Experiment, University of New Hampshire.
This experiment will measure the magnitude and direction of the earth's magnetic field between 5 and apogee to investigate the termination of the geomagnetic field in the vicinity of 10 earth radii. The data will be examined for information concerning hydromagnetic waves, ring currents, particularly in

relation to solar events and changes in particle intensities. Objectives are:

To determine the existence and the location of a "ring" current. Variations of such a current, both in spatial position and in time, would be investigated.

Data will be examined for rapid changes of the magnetic field in time. These might be interpreted together with information from round magnetic observatories, as evidence for the propagation of hydromagnetic waves.

Time variations in the magnetic field will be compared with surface magnetic measurements and with records of solar activity in an attempt to discover possible correlations, particularly during magnetic storms. The time variations in the field will be compared with the variations in particle intensities. The direction of the magnetic field will be available for comparison with directional characteristics of the particle intensities.

The magnetometer is a three-core device. Each of the three orthogonal sensors produce an output voltage proportional to the magnitude of the component of the combined magnetic field along that sensor. The output voltages of the three sensors each occupy a separate channel and are combined after reception to form the total magnetic field vector. The range of measurements are from a few gammas to 500 gammas. The accuracy of the telemetered data is ± 5 gammas.

Trapped Particle Radiation Experiment, State University of Iowa. This experiment will measure the characteristics of particle radiation over the entire satellite orbit. This radiation may be considered in three categories: trapped particles; solar particles; and cosmic rays. Of interest are the fluxes and energies of particles of various types, and their spatial and temporal dependence.

Instrumentation includes four Geiger counters and a telemetry encoder. One Geiger tube (Anton-type 302) will have characteristics similar to one flown by the State University of Iowa on Explorer VII and Explorer XII, and by the University of Minnesota on Pioneer V. This will detect particles arriving from every direction. It will measure protons above 20 Mev and electrons above 1.6 Mev.

Three Geiger-Mueller directional detectors having identical mechanical and electrical characteristics are on board. They are Anton-type 213 thin-window Geiger tubes. Two of the

Geiger tubes have identical window thicknesses, but one has a magnet to remove only low energy electrons. The third has a window but no magnet. They look out through apertures in the side of the satellite and have look angles of **approximately** 35- to 40- degrees in diameter. They will measure the electron and proton spectrum in three integral slices. The lower limits of the electron slices are 40, 250 and 250 kev. The lower limits of the proton slices are 500 kev, 5 Mev. and 4 Mev. All three detectors are shielded by 4.5 g-cm^{-2} of lead, except over their front windows.

A data encoder accumulates counts to feed a scaling unit for 10.24 seconds, which is read-out serially twice, as a series of binary bits. The detector scalers then are reset to zero, and the next detector is selected. An on-board clock, or frame counter and its scalers is reset only after its total time has run out (approximately 6 months). Then it is reset to zero for another six-month sequence.

The energies of particles of different types which can be detected by the apparatus are:

<u>Detector</u>	<u>Particles</u>	<u>Detector Response</u>
213 Geiger directional detector	Electrons Protons	40 kev and above 500 kev and above
213 Geiger directional detector	Electrons Protons	250 kev and above $1/2$ Mev and above
213 Geiger directional detector	Electrons Protons	250 kev and above 4 Mev and above
302 Geiger omnidirectional detector	Electrons Protons	1.6 Mev and above 20 Mev and above

Cosmic Ray Experiment, Goddard Space Flight Center. The most important problems in cosmic rays are the nature of the accelerating mechanism and the nature of the modulation mechanism which produces the 11-year variation and the Forbush-type decrease. An accelerating mechanism which can produce particles with energies up to 10^{18} ev and a modulation mechanism which can influence particles with energies greater than 10^{10} ev both appear to have important astrophysical implications. The theoretical explanations for these phenomena are hopelessly inadequate at this time and additional experimental information is needed.

The cosmic ray package consists of three basic units. The first detector is a double scintillation telescope where the pulse from one of two counters is selected for a given event. This telescope has been thoroughly tested on a large number of high-altitude balloon flights. The unit provides information on: the total cosmic ray flux; the flux of fast protons with energies greater than 700 Mev; the proton differential energy spectrum in the region 70-75 Mev; and the low-energy portion of the Alpha particle differential energy spectrum.

When a particle traverses the two scintillators, a coincidence is formed and the pulse height from one of the scintillation counters is processed by a 32-channel analyzer. Data is accumulated in the analyzer's magnetic core memory for four minutes and is then read-out serially. Read-out is nondestructive. Channel capacity is 2^{10} -per-channel.

To extend the proton energy spectra data down to 1 Mev, a thin cadmium sulphide scintillation counter is used. Pulse height distribution of incident particles is obtained from 100 kev to 20 Mev by a sliding channel pulse height analyzer. This unit also provides information on low-energy solar gamma rays.

The thin scintillation counter is connected to an integral discriminator whose bias is furnished by an eight-level staircase generator. A data accumulator is subcommutated between the eight levels and the three Geiger counter inputs. In each case the actual number of counts per-unit-time is transmitted. Appropriate identification is provided for each read-out. When the multichannel analyzer is read-out, other inputs are disconnected.

Two Anton 1003 Pancake-type Geiger counters make up the third detecting unit. One is shielded with 2 gms/cm². The effective geometric factors of these counters are several orders of magnitude larger than those in the first package and are cosmic ray monitors. The rate of the shielded counter and coincidence rate of the two combined counters will be telemetered. These units furnish a check on the information received from the scintillation counter units.

Objectives and range of detectors are:

Double scintillation
telescope

Measure total cosmic-ray
flux

	Measure proton energy spectrum in region 70 to 750 Mev
	Measure low-energy spectra, alpha particles
	Measure total flux fast protons in region above 700 Mev.
Single crystal detector	Proton and electron energy spectrum. 100 kev $< E < 20$ Mev
	Low-energy gamma rays
G-M Telescope	
Shielded	Proton flux > 75 Mev Electron > 8 Mev
Coincidence	Cosmic ray flux > 75 Mev

Ion-Electron Detector Experiment, Goddard Space Flight Center. This experiment will measure particle fluxes, types, and energy as a function of direction, time, and position below, in, and above the Van Allen radiation belt.

The ion-electron scintillation detector has a phosphor powder ZnS (Ag), settled on a photomultiplier tube located behind a stepping absorber wheel. The dc current and pulse counting rates are measured simultaneously for each absorber position.

Ion counting rates for two trigger levels are registered for seven absorber thicknesses. From this, ion types and energy spectra can be deduced. In these measurements, electrons are discriminated against by the phosphor characteristic; the emitted light decay time being inversely proportional to the square of the ionization density.

Electron energy flux is known by scattering the incident electrons off a gold plate (ions will be absorbed) onto the phosphored photomultiplier tube, giving measurable dc currents. Electron energy spectra can be deduced by comparing the

responses from six absorber thicknesses. The total energy flux is obtained for seven absorber thicknesses by measuring the photomultiplier dc current.

The ion detector is operative from 100 kev to 1 Mev for protons with maximum counting rates of 10^5 cps in each channel. The electron detector with a dynamic range of 10^5 is operative for electrons between 10 kev and 100 kev. For average photomultiplier voltage, the minimum detectable energy is 10^{-2} ergs/seconds.

The total energy flux detector with a dynamic range of 10^5 is operative over the energy range of 30 kev to 1 Mev for protons, and 10 kev to 100 kev for electrons. For average values of photomultiplier voltage, the minimum detectable flux is 2×10^{-2} ergs/seconds. The detectors and their range of response are:

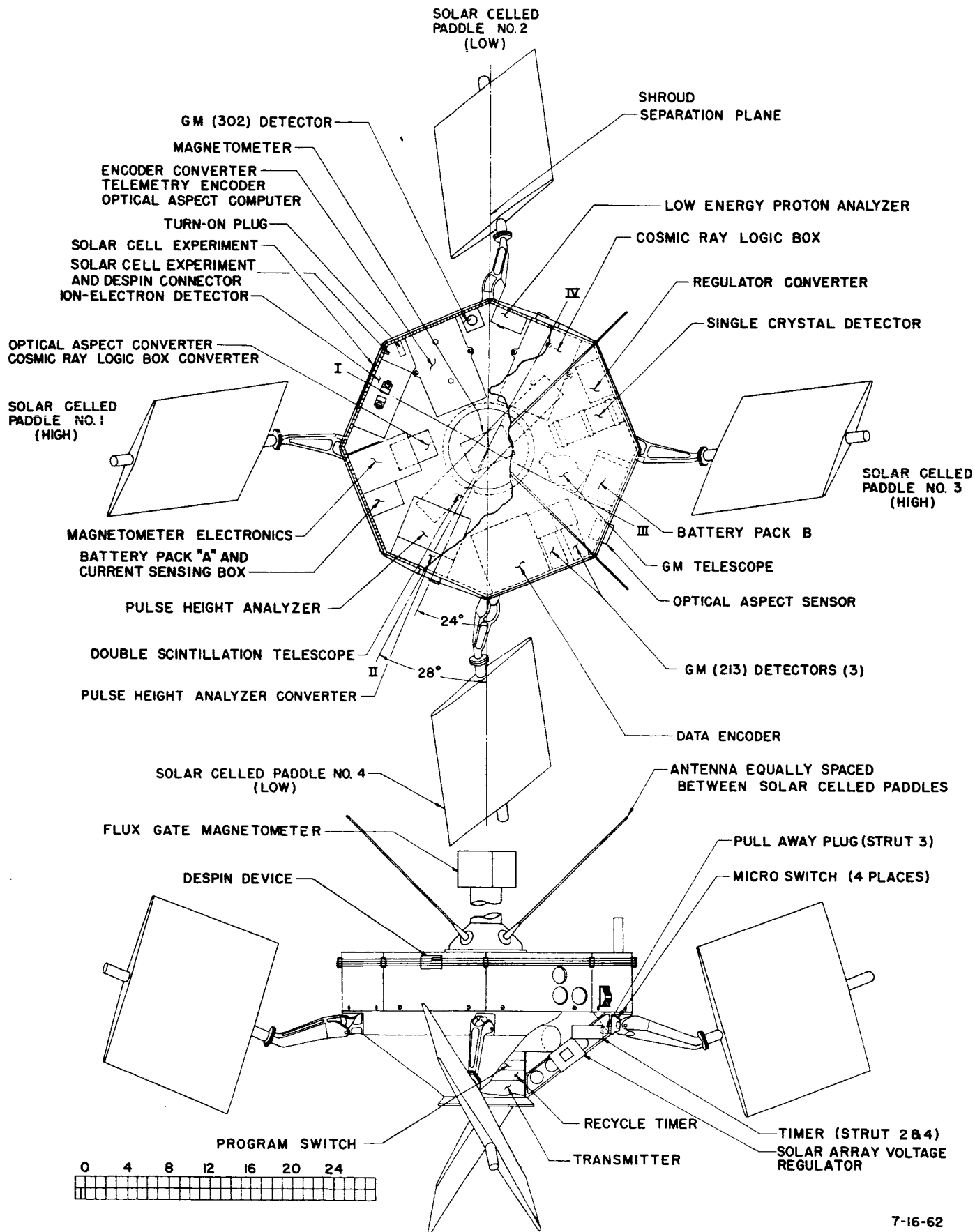
Ion Detector	Protons	100 kev > E < 1 Mev
Electron Detector	Electrons	10 kev < E < 100 kev
Total Energy Detector	Protons	30 kev < E < 1 Mev
	Electrons	10 kev < E < 100 kev

Solar Cell Damage Experiment, Goddard Space Flight Center.

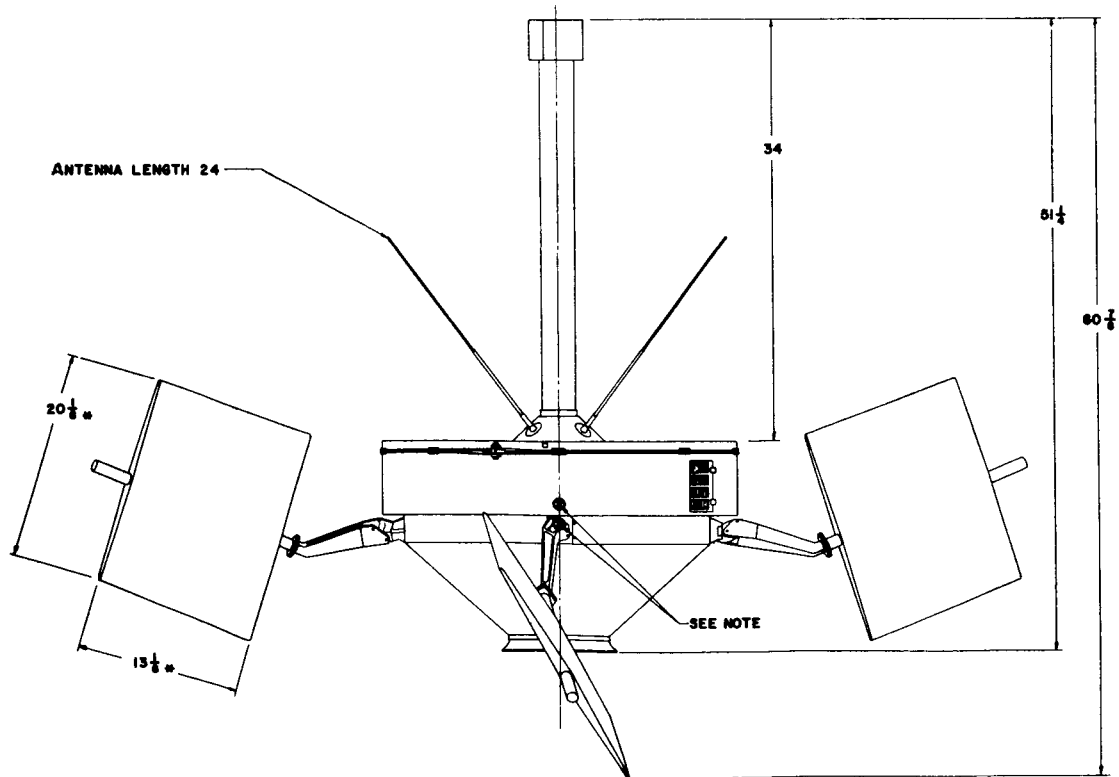
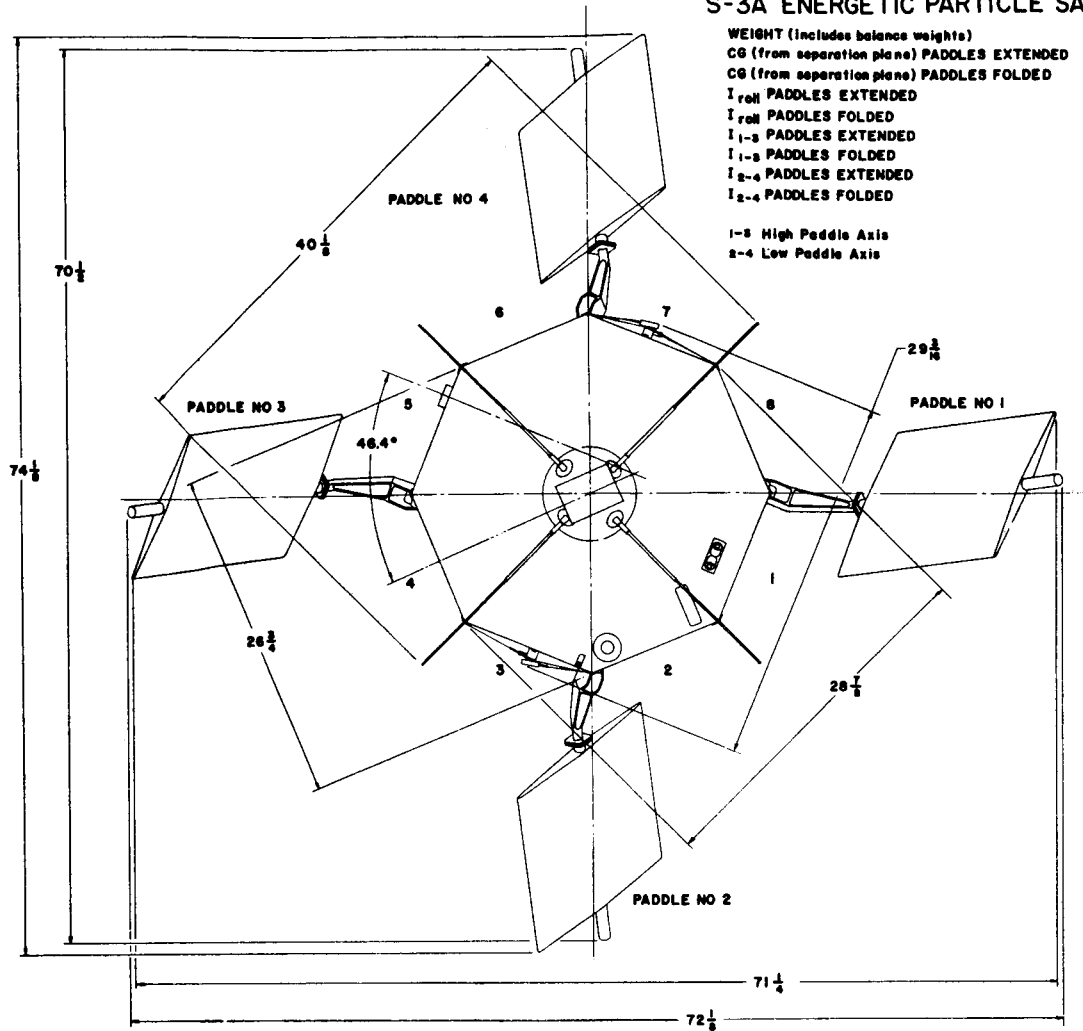
This experiment will compare the deterioration of P on N and N on P solar cells caused by direct exposure to radiation. Four strips of silicon-gridded shallow-diffused solar cells, with ten cells per strip, are mounted on the outside of the spacecraft. Two strips are made up of P on N cells and two with N on P cells. One strip of each type of cell is unprotected while the other has 3 mil microslide shields on each cell. During the life of the spacecraft it will be possible to compare the effectiveness of the different types of cells, with and without glass shields, in preventing degradation due to radiation. Telemetry provides four voltage measurements on a time-sharing basis.

- END -

S-3A ENERGETIC PARTICLES SATELLITE



S-3A ENERGETIC PARTICLE SATELLITE



* TRUE LENGTH

OUTLINE DRAWING

7-16-62